LAr1: Addressing the short-baseline anomalies

Anomalous signals observed by LSND, MiniBooNE, and short-baseline reactor anti-neutrino experiments suggest beyond-standard-model physics (see [1] for a comprehensive review). A new physics and R&D program, using multiple liquid argon time projection chamber detectors (LArTPCs) placed in the on-axis Booster Neutrino beam (BNB) at Fermilab, could definitively address these short-baseline anomalies while also serving as a kiloton-scale engineering prototype for future LArTPCs detectors.

This new program proposes to combine the MicroBooNE detector (170t) located at 470m along the BNB with a smaller (25t) LArTPC located in the SciBooNE hall at 100m and a larger (3kt) detector located at 700m, as illustrated in Figure 1. This configuration has been chosen to optimize sensitivity to the full parameter space allowed at 99% by LSND under the 3+1 sterile neutrino oscillation hypothesis.

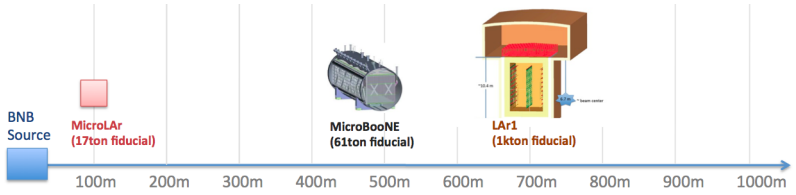

Figure 1: Optimized configuration for a 3 LArTPC detector configuration on-axis in the Booster Neutrino Beam at Fermilab.

The $\nu_\mu \rightarrow \nu_e$ and $\bar{\nu_\mu} \rightarrow \bar{\nu_e}$ 3+1 appearance sensitivities for this detector configuration are shown in Figure 2. The sensitivities assume 80% reconstruction efficiency for ν_e charged-current events, an overall 5% systematic uncertainty on the backgrounds and 6.6e20/10.0e20 protons on target (~3/5 years of running) for neutrino/anti-neutrino modes.

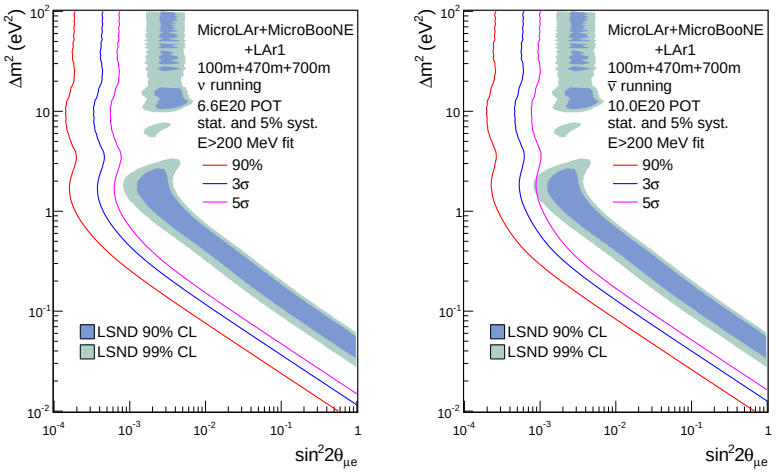

Figure 2: Sensitivity to a 3+1 sterile neutrino model for a 3 LArTPC detector configuration in the BNB in neutrino (left) and anti-neutrino modes (right).

The proposed configuration takes significant advantage of existing infrastructure and builds upon the current BNB neutrino physics program at Fermilab. It would address in a definitive way whether the observed short-baseline anomalies are due to high Δm^2 neutrino oscillations. The multiple detector combination provides a powerful constraint of experimental uncertainties and delivers the sensitivity necessary to answer this important open question in neutrino physics.

References

[1] Abazajian, K. N. et al., (2012) Light Sterile Neutrinos: A White Paper, (arXiv:1204.5379).